Comparing Dominant and Non-Dominant Torque and Work using Biodex 3 Isokinetic Protocol for Knee Flexors and Extensors

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INTRODUCTION

There is often a misconception when looking at comparing dominant and non-dominant limbs of any sort. Although there will be a lack of control in non-dominant limbs compared to dominant, the amount of torque and power associated with each limb may be equal; even so, there may be an instance of bilateral deficit, where even though the dominant limb may be used to do work on a specific limb, the non-dominant limb may still receive strength benefits. There was an equal mean torque and mean overall work in the subjects tested, which leads to the conclusion that unskilled, gross motor skills may not be affected by dominant and non-dominant labeling (1). When directly relating research to this topic, one may find that there is a necessity for sport-specific research in how to train dominant and non-dominant limbs to produce an equal torque and total work outputs. Significant differences were not identified when bilaterally comparing knee flexors and extensors between different modalities (3). It may also be important to study this topic for 2 main reasons; a) the ability for dominant and non-dominant limbs too function at equal outputs would be beneficial for any population, this could lead to prevention of injury or a multitude of sport-specific and non-specific reasons, b) to provide factual information about the functional ability of non-dominant limbs, as they compare to their dominant counterparts. Through this topic, one will be able to compare dominant and non-dominate torque and total work for both isokinetic knee flexion and extension. Isokinetic exercise involves three phases of movement; acceleration, constant velocity, and deceleration (2). This will help to provide insight into how equal, or unequal, limb ability may be.

PURPOSE

The main purpose of this study is to directly relate ability (torque and total work) in both dominant and non-dominate limbs with a focus on knee flexion and extension. A secondary purpose of this lab is to test ability over various speeds utilizing the Biodex System 3 Isokinetic Device and to gain a better understanding of the testing protocol and how to properly use specific equipment.

METHODS

Participants

Four (N = 4; 4 males, 0 females) “volunteers” from the KINE 533C course were utilized for this study. The average age of the participants were 24.5 $\pm$ 1.73 years old, average height was 71.75 $\pm$ 3.20” (inches or 182.245 centimeters), and average weight was 183.26 $\pm$ 45.78 pounds (83.3 kilograms).

Methodology

Each participant met in the lab Wednesday July 13th to complete the lab. Upon arriving to the lab, each participant was measured for height (recorded in inches) and weight (recorded in kilograms), as well as age was recorded (years). After background data was recorded, the Biodex System 3 was booted. Each participant was added into the system when they attempted to perform the protocol. The established protocol set-up was isokinetic in nature. The protocol utilized isokinetic concentric/concentric contractions on the knee for three separate speeds or sets (30°/s, 60°/s, and 90°/s); each set included 5 repetitions. Following protocol set-up, each participant would be set-up to attempt the protocol using the non-dominant leg. Prior to the test being conducted, the Biodex would be adjusted for each participant to use the equipment. The chair would need to be adjusted for each individual and would be set at an established point. The established point for knee flexion/extension would be for the tibia-femoral joint, along with the patella to be in line with the movement arm of the Biodex; this would be performed by the practitioner. Upon completion of manipulating the Biodex chair, the subject would be strapped in to allow for limited mobility outside of knee flexion/extension. The range of motion would then be set for each participant. The reference point set would be the knee as close to 90° as possible. The participant would make their limb as limp as possible and the practitioner would lift their leg until full extension was made; there is a "hold" button on the Biodex that allows for the stabilization of the limb. The practitioner would push this "hold" button and set the extension range of motion. The "hold" button would be pushed once again and the leg would be released. The participant would then flex their leg until full flexion had occurred or the Biodex would no longer allow flexion. The "hold" button would be pressed and the flexion portion of the range of motion would be established. The "hold" button would be pushed once again to release the limb. The practitioner would then pull the leg back into full extension, press the "hold" button and set the limb weight. The "hold" button would be pressed once again, the limb would be set in the reference position and the participant would be ready to complete the protocol. Upon completion of each set (5 repetitions) the participant would be allowed 10 seconds of rest. After all of the sets were complete the participant would be allowed off the Biodex. Following the same protocol, all participants would complete the test using their non-dominate leg. After all participants performed the protocol with their non-dominant leg, they would then utilize the same set-up and protocol with their dominant leg.

Statistics

Statistics would be run on the recorded data. The mean (average) and standard deviation was found utilizing Microsoft Excel Formula, the percent difference was found utilizing hand calculations and formula set-up through Microsoft Excel, and a two sample t-Test assuming equal variances (alpha 0.05) was performed utilizing Microsoft Excel Data Analysis Pack.

RESULTS

<u>Mean Torque and Mean Total Work</u>

Dominant Knee Flexion

30°/s
Mean Torque = 127.5 N·m
Mean Total Work = 558.5 J
60°/s
Mean Torque = 120 N·m
Mean Total Work = 579.5 J
90°/s
Mean Torque = 144 N·m
Mean Total Work = 665.5 J

Dominant Knee Extension

30°/s
Mean Torque = 214 N·m
Mean Total Work = 823.25 J
60°/s
Mean Torque = 194 N·m
Mean Total Work = 833 J
90°/s
Mean Torque = 149.5 N·m
Mean Total Work = 663.75 J

Non-Dominant Knee Flexion

30°/s
Mean Torque = 127.5 N·m
Mean Total Work = 536.75 J
60°/s
Mean Torque = 121.25 N·m
Mean Total Work = 578.75 J
90°/s
Mean Torque = 115.25 N·m
Mean Total Work = 557.5 J

Non-Dominant Knee Extension

30°/s
Mean Torque = 258.75 N·m
Mean Total Work = 909.5 J
60°/s
Mean Torque = 225.75 N·m
Mean Total Work = 903.75 J
90°/s
Mean Torque = 206 N·m
Mean Total Work = 836.5 J

Percent Difference

Flexion-Torque

	Dominant	Non-Dominant	Percent Diff.
30°/s	127.5 N·m	127.5 N·m	0.0%
60°/s	120 N·m	121.25 N·m	1.23%
90°/s	144 N·m	115.25 N·m	19.97%

Extension-Torque

	Dominant	Non-Dominant	Percent Diff.
30°/s	214 N·m	258.75 N·m	17.29%
60°/s	194 N·m	225.75 N·m	14.06%
90°/s	149.5 N·m	206 N·m	27.43%

Flexion-Work

	Dominant	Non-Dominant	Percent Diff.
30°/s	558.5 J	536.75 J	3.89%
60°/s	579.5 J	578.75 J	0.13%
90°/s	665.5 J	557.5 J	16.23%

Extension-Work

	Dominant	Non-Dominant	Percent Diff.
30°/s	823.25 J	909.5 J	9.48%
60°/s	833 J	903.75 J	7.83%
90°/s	663.75 J	836.5 J	20.65%

t-Test Two-Sample Assuming Equal Variances

alpha = 0.05

Dominant/Non-Dominant Flexion-Torque 30/60/90 °/s
No significant measurement found.

Dominant/Non-Dominant Flexion-Work 30/60/90 °/s
No significant measurement found.

Dominant/Non-Dominant Extension-Torque 30/60/90 °/s
No significant measurement found.

Dominant/Non-Dominant Extension-Work 30/60/90 °/s
No significant measurement found.

Most of the results were expected; however, the value and percent difference associated with dominant and non-dominant extension (both torque and work) were rather large. As seen in the percent difference section, the value of each percent difference were at least 7.83% (min) and as high as 27.43% (max). There was also a noticeable percent difference associated with 90°/s in flexion for both torque and work between dominant and non-dominant with values at torque = 19.97% and work = 16.23%.

This may bring up a valid point. Fine motor movement may be limited between dominant and non-dominant limbs, but the ability to product torque and work may not be as easily affected by which is dominant and non-dominant.

DISCUSSION

Overall

This study may help provide insight into how dominant and non-dominant limbs may be trained and how they may be equal even without training. The fact that the non-dominant leg had higher values during extension in both total mean work and mean torque, may lead one to believe that the non-dominant leg may be more powerful than the dominant. When comparing dominant and non-dominant flexors and extensors in high school wrestlers, there is seen a significant difference between the extension qualities of the dominant and non-dominant leg; the non-dominant leg has an increased torque to work ration when compared to the non-dominant (2). When compared to the non-control group, the control group had similar values between dominant and non-dominant limbs (4). This may be untrue due to many variables, but this study has allowed a certain insight into how dominant and non-dominant limbs may be equal in gross motor movements. Results that find non-dominant to dominant differences may be errors due the tester and/or the participant; it may be due to the participant because of situational awareness, they may learn the protocol and movements with one leg and adjust using the other (5).

Limitations/Delimitation

There are many limitations to the study that was performed.
The main limitation to this study was the unawareness the practitioner may have had about the equipment. Tester error is usually the leading cause as to why there may be an error or bias seen in a study.
A secondary limitation would be the participant being unaware which leg may be there dominant leg; in certain cases the participant may have a dominant leg, but it may be injured, thus skewing results.
A third limitation would be the fact that there were only four (4) participants for the study and that they were all male.
A delimitation of this study would be the decision to only use the Biodex. A few other delimitations would be the use of only concentric isokinetic contractions and the fact that it was a lab setting where no outside influences could affect the outcome of the test.

CONCLUSION

In conclusion, the test showed some variables that previously might have gone overlooked. The fact that the non-dominant leg produced the same, if not better, results than the dominant leg may bring about future study opportunities utilizing a Biodex System 3 protocol. It is important to understand individual differences for this study and would optimal to have each participant provide a medical background on any previous injury that could affect the outcome of the protocol. Future research will be needed to back-up findings from this study and the use of a standardized methodology must be incorporated to provide accurate results.

PRACTICAL APPLICATION

There are many practical applications of this study. It could be utilized to test an athlete’s ability in both their dominant and non-dominant limb and provide a means to direct a training regimen towards an equalizing goal. It may also be useful in treating participant’s injuries, or a baseline assessment to provide products that can be used to put together a rehabilitation program. It may also be utilized to test the effects of bilateral deficit on any population and the effects that it may have on both dominant and non-dominant limbs, especially in the knee. In any case, the use of this protocol and the use of the Biodex System 3 remain almost limitless. The ability to change from a pure isokinetic concentric/concentric contraction to isokinetic eccentric/concentric or even isokinetic concentric/eccentric contractions, and isometric contractions makes this an invaluable tool for any exercise physiology lab, physical therapy clinic, health care setting, or even a research setting.

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